Towards the Development of a Web-Based Application for Chronic Pain Management Using Persuasive Technology

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Abstract

The topic of pain management systems has been around based on existing studies. However, existing systems are still limited, especially with the application of persuasive technology and UX/UI principles in pain management. The objective of this systematic review paper was to gain knowledge and provide existing parameters in developing a web-based application for chronic pain management using persuasive technology. A total of one hundred fifty-seven (157) studies/papers were collected from the year 2017 and they were filtered down based on title, abstract, and full-text eligibility. Fifty-one (51) studies were chosen to be included in this review paper, which presented the elements and evaluation of UX and UI in eHealth applications, the persuasive design models and principles, and the components in remote chronic pain management system, in which all of them could be used as a basis in developing a web-based application for chronic pain management using persuasive technology. Furthermore, after basing on the presentation from the existing studies, this review paper also proposed a development model for the chronic pain management web application that also applies persuasive technology.

Keywords

Persuasive Technology, User Experience, User Interface, Chronic Pain, and Pain Management

1. Introduction

With how eHealth systems and applications' main goal is to influence and help its users as much as it can, its factors of usability when it comes to its purposes and features are vital to its successful implementation, this is especially so with the fact that it involves the user's health (Maramba et al. 2019). As such, any health-related application should be tested for its usability factors such as its user experience and user interface to ensure that the application is appropriately and suitably designed and tailored to its target end-users needs. It is studied and observed that there have been multiple publications that delve into the valuation of the user experience eHealth applications (Hajesmaeel-Gohari et al. 2022), for the sake and goal of creating a new eHealth system, the paper seeks to explore these studies in order to build an optimal user experience design along with the methods for evaluation. Persuasive technology, first developed by B.J. Fogg (Kim et al. 2019), refers to the relationship between information and communication technology (ICT) and the art of persuasion (de Toledo et al. 2018). It is an area or study of human-interacting technology that seeks to influence or change the behavior of an individual. In relation, many eHealth interventions have the objective of changing behavioral habits or routines in favor of more healthy behavior (Lucero et al. 2022). As such, persuasive user experience designs have shown to be beneficial in web and mobile-delivered health interventions (Lucero et al. 2022). While applicable in multiple disciplines, the use of persuasive technology in the area of health is popular, as evidenced by the studies (Kim et al. 2019**;** Bartlett et al. 2017**;** Alpay et al. 2019). Pain is defined as the unpleasant feeling one feels due to potential or actual tissue damage. It could also be caused by other damages with no physical disorder (Finnerup 2019). Pain could be classified as chronic pain which is a recurring pain that persists for more than 3 months (Devan et al. 2019). It is a common reason for people seeking medical care, a leading cause of disability and one of the most widespread diseases around the world (Ghai et al. 2020**;** Finnerup

2019**;** Varsi et al. 2021). That being said, services in regards to chronic pain management is essential (Ghai et al. 2020). In this review paper, it would help identify existing trends, strategies or components that could help in the creation of a pain management system for chronic pain

There exist many researches discussing the application of persuasive technology for behavioral changes in eHealth in the last five years. As such, this study aims to propose the development of a web application applying persuasive technology for remote chronic pain management based on one hundred and fifty-seven (157) studies collected from 2017 to 2022. However, one study from 2009 was acquired as it is the origin of one of the frameworks referenced in another study. Thus, this paper presents the elements, frameworks or principles, and components generally used in eHealth products applying persuasive technology to influence behavior.

1.1 Objectives

The goal of this systematic literature review is to identify the following: (1) the user experience and user interface elements of eHealth web applications and systems to apply towards the study, (2) theoretical frameworks or bases for the development of a web application applying persuasive technology in its user experience design, and (3) components or modules required in remote chronic pain management.

2. Methodology

The systematic review paper focuses on gathering and reviewing a collection of studies that are related to the topic of developing a web-based application for chronic pain management using persuasive technology. Figure 1 shows a visual presentation of the methodology used to produce a list of studies to be included in the review paper and it could be explained with 5 steps:

Step 1: Selection of Studies. Possibly related and relevant studies were collected from different source databases. The studies that were screened and included in this systematic review paper where from the following source databases: ACM Digital Library, AIS eLibrary, ScienceDirect, JMIR Publications, IEEE Xplore, SAGE Journals, Springer link, PubMed, PubMed Central, ResearchGate, Hindawi, Taylor and Francis Online, Oxford Academic, and Google Scholar. A total of one hundred fifty-seven (157) studies were gathered from different source databases during the selection process.

Step 2: Removal of Duplicates. The gathered studies from the first step were checked for any duplicates, which resulted in zero (0) duplicates. Therefore, there were still 157 studies to filter after the removal of duplicates.

Step 3: Filtering by Title. The 157 studies were then filtered depending on how relevant they were based on their titles. A total of fifty-five (55) studies were excluded in this step, which resulted to one hundred two (102) studies left to filter in the next step.

Step 4: Filtering by Abstract. The 102 screened studies were filtered according to their abstracts, which resulted in thirty-eight (38) studies excluded, making it sixty-four (64) studies left for full-text eligibility assessment.

Step 5: Filtering by Full-text. The full-text of the remaining 64 studies were read and analyzed to determine if their contents were relevant and could be used for the purpose of this review paper. The number of studies chosen after filtering by full-text was fifty-one (51), which could be grouped by source database: Google Scholar = 15, JMIR Publications = 10, PubMed = 8, ScienceDirect = 4, Springer Link = 3, IEEE = 3, SAGE Journals = 3, Oxford Academic = 1, PubMed Central = 1, ACM = 1, ResearchGate = 1, AIS eLibrary = 1. The 51 studies were chosen for they were the most relevant to the review paper as each of them include or discuss at least one of the following criteria or topics (all of which were based on studies related to each of them):

a. eHealth services design in regards to UX (User Experience), with the studies evaluating the user experience using System Usability Scale (SUS) form (Hurmuz et al. 2020), and User Experience Questionnaire (UEQ) (Kushendriawan et al. 2021), and other methods of user experience evaluation.
b. eHealth intervention or web application focusing on behavioral change (Asbjørnsen et al. 2019).
c. implementation of persuasive technology or persuasive design principles or models (Qasim et al. 2018).
d. evaluation of persuasive technology in its design implementation towards health and wellness (Orji and Moffatt 2018).
e. concepts/applications capable of addressing pain conditions that allow for proper evaluation/assessment and/or management of a patient's pain condition (Finnerup 2019**;** Ghai et al. 2020).

f. concepts/applications that are able to provide information on at least one of the following strategies for managing pain: pain education, thought and behavioral management, exercises, activity pacing, relaxation or breathing, or meditation (Devan et al. 2019).

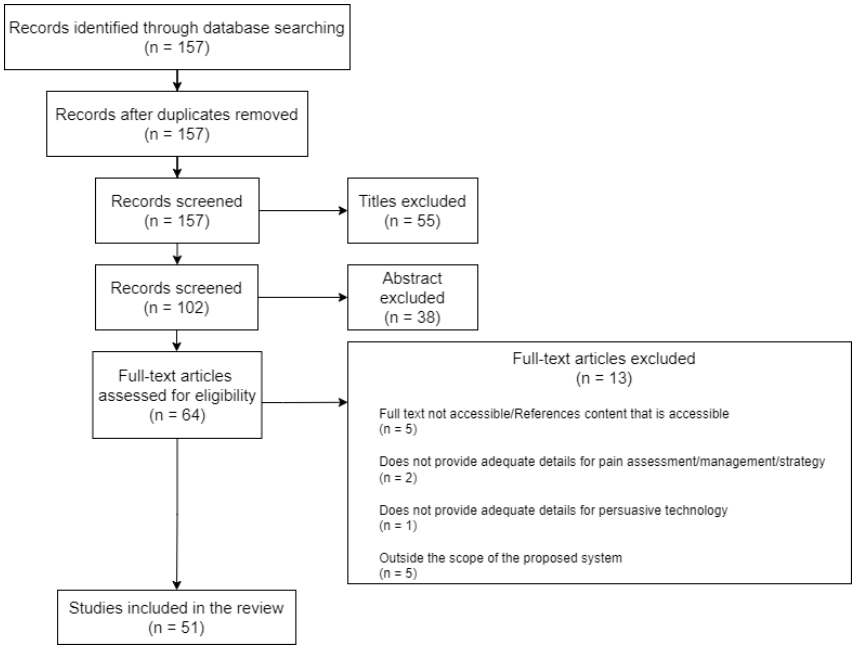

Figure 1. Study Filtering Methodology

3. Results and Discussions

3.1 Elements and Evaluation of UX and UI in eHealth Applications

The studies for this section are selected based on the first criteria in which a published paper has to evaluate the user experience of eHealth applications. Although usability and user experience are subjective, the elements of what makes a health-related system usable and have optimal user experience can still be defined. The quality of eHealth user experience can be evaluated by its users via questionnaires, with there being numerous different established and reliable questionnaires that are used for health-related technologies (Maramba et al. 2019; Hajesmaeel-Gohari et al. 2022). The various elements of what defines usability in these selected studies whether they are defined in-text or from established questionnaires are then utilized and applied towards the development and evaluation of the new proposed system. **Usability** – is defined as the extent to which a product can be used by its target users to do its intended or made purpose with satisfaction, effectiveness, and efficiency. (Newton et al. 2021). Questionnaires can be used to obtain measures of how usable a health application is (Melin et al. 2020; Touzery et al. 2019). in which is commonly assessed by the System Usability Scale (SUS) as a reliable way for the subjective assessment of the usability of an application (Islam et al. 2020; Anderson 2021; Marien et al. 2018; Rybarczyk et al. 2018). SUS aims to evaluate the learnability, usability, and satisfaction of an application based on a score (Pérez-Rodriguez et al. 2021; Finkelstein et al. 2022). **Interface** – It is the visual aspect of the application, (Yu and Huang 2020; Agusdin et al. 2021). An attractive and easy-to-use interface is regarded as contributing to a good user experience. An interface should also include pleasing colors (Copeland et al. 2018), and a pleasing aesthetic (Hurmuz et al. 2020). **Purpose** – the user must be able to easily define and understand the application purpose (Copeland et al. 2018). **Practicality** – this can be defined as the quality of the application design for actual use (Agusdin et al. 2021).

According to the User Experience Questionnaire (UEQ), there are six scales of user experience which are: Attractiveness, Efficiency, Perspicuity, Dependability, Stimulation, and Novelty. The UEQ is a an easy and reliable for quality assessment (Kushendriawan et al. 2021). UEQ has been known to be used, applied, and evaluated for eHealth-related applications (Kushendriawan et al. 2021; Pérez-Rodriguez et al. 2021; Liu et al. 2020). The rest of the elements below are elements that are used in UEQ. However, its listed definitions and use are not derived from the UEQ only, as some other studies that do not make use of UEQ have shown or have claimed to have the same elements

for user experience: **Attractiveness** – overall impression of the product. Attractiveness is not just limited to visuals, but is defined as if the users generally like or dislike the application (Kushendriawan et al. 2021; Liu et al. 2020). **Efficiency** – defined as if the user can achieve their intended goals using the application quickly and efficiently and with not much effort (Kushendriawan et al. 2021; Liu et al. 2020; Agusdin et al. 2021). **Perspicuity** – is defined as how effortless understanding or getting familiar with how to use the product is (Kushendriawan et al. 2021; Liu et al. 2020). This can also be defined, or have the same meaning as Ease of use (Finkelstein et al. 2022). **Dependability** – this is how much the user is in control of the functions of the application, with what it could do being predictable by the users (Kushendriawan et al. 2021; Liu et al. 2020). **Stimulation** – this is how exciting, interesting or fun it is for the users to use the application (Kushendriawan et al. 2021; Liu et al. 2020). **Novelty** – the user's impression of the application's purpose or functions if it is creative or innovative (Kushendriawan et al. 2021; Liu et al. 2020).

In regards to the selected evaluation of user experience for its effectiveness itself, it is established that there are several widely known methods of evaluating the user experience application eHealth applications, with the most used method being the System Usability Scale or SUS (Maramba et al. 2019; Hajesmaeel-Gohari et al. 2022). The paper however sees it best to consider what the selected studies have used for their own evaluation of eHealth user experience as the selected studies best fit our own criteria and goals. Table 1. shows a list of the selected publications based on meeting the first criteria (in which are publications focusing on e-health services design and evaluation in regards to UX) and what UX evaluation method each paper used for its own eHealth application and study.

Table 1. User Experience Evaluation Methods Used

User Experience Evaluation Method	Description	No. of Studies	References
SUS	System Usability Scale	7	Hurmuz et al. (2020); Islam et al. (2020); Anderson (2021); Marien et al. (2018); Rybarczyk et al. (2018); Pérez-Rodriguez et al. (2021); Finkelstein et al. (2022)
UEQ	User Experience Questionnaire	3	Kushendriawan et al. (2021); Pérez-Rodriguez et al. (2021); Liu et al. (2020)
UMUX-LITE	Usability Metric for User Experience - Lite	1	Copeland et al. (2018)
PSSUQ	Post-Study System Usability Questionnaire	1	Setiawan et al. (2019)
Others	Other UX evaluation tools only used once	5	Hurmuz et al. (2020); Melin et al. (2020); Touzery et al. (2019); Yu and Huang (2020); Agusdin et al. (2021)

Review studies that do not evaluate their own eHealth application are excluded from this table. Resulting in 16 studies. Most prevalent method used is of the System Usability Scale with 7 next to User Experience Questionnaire having 3.

All seven (7 out of 7) studies that have made use of SUS, makes use of the its usability questions to assess the subjective nature of good usability, the ten questions used in the survey are all regarded as qualities in order for their medical application to have “good usability”. Aspects such as how easy to learn the system is, how dependable the system is, and others all factor in to good usability. A SUS score of above 68 is regarded as acceptable. Of the 7 studies, only one study from Islam et al. (2020) have reportedly had an “unsatisfactory” score of below 68 out of the study’s multiple SUS tests, associating more usability problems with less usability score, expressing importance of minimalistic or uncomplex design (Islam et al. 2020; Anderson 2021). For the UEQ, all 3 studies make use of the aforementioned five elements of what makes good user experience (Attractiveness, Efficiency, Perspicuity, Stimulation, and Novelty). All have reported to have above average or satisfactory UEQ scores, hence successfully implementing these elements into their eHealth systems. One study however mentions that their weakest aspect was of Novelty, which pertains to the applications originality (Liu et al. 2020).

3.2 Persuasive Design Models and Principles

In the study, there are eleven papers or articles focused on implementing, examining, or discussing persuasive technology. Among the eleven, nine concentrate on implementing models or principles that fall under the aforementioned area. The most famous among them is the Persuasive System Design (PSD) developed by Oinas-Kukkonen and Harjumaa. The following table 2 further discusses the models or principles and their application.

Table 2. Persuasive Models and Principles

Description	No. of Studies	Application	References
Persuasive System Design	5	Self-health Management, Behavioral Change, Increase of Physical Activity	Kim et al. (2019); Lucero et al. (2022); Bartlett et al. (2017); Alpay et al. (2019); Coorey et al. (2019)
Fogg Behavior Model	3	Assessment, Development, Self-health Management	de Toledo et al. (2018); Alpay et al. (2019); Theopilus et al. (2018)
Therapeutic Persuasiveness	1	Assessment, Behavioral Change	Baumel et al. (2017)
Cialdini's Principles of Social Influence	1	Assessment	Ibrahim et al. (2018)

Persuasive System Design (PSD). The PSD developed by Oinas-Kukkonen and Harjumaa (2009) features three phases in developing persuasive systems. The first focuses on seven primary postulates that are to be addressed when designing or evaluating a persuasive user experience design. Once addressed, the context or setting of the persuasive system must be analyzed (intent, event, and strategy). Afterwards, this leads to the designing of the system qualities or features, which manifest in four categories: primary task support, dialogue support, system credibility support, and social support. Each category has its own set of principles. Figure 2 best illustrates the PSD framework. Of these studies that make use of the PSD framework, only 2 studies (Lucero et al. 2022; Coorey et al. 2019) specifically mention what principles are used under each persuasive category applied. It was discovered that 4 (Lucero et al. 2022; Bartlett et al. 2017; Alpay et al. 2019; Coorey et al. 2019) of the 5 studies have primarily found the most success with Primary Task Support in changing subject behavior. Both studies (Lucero et al. 2022; Coorey et al. 2019) have largely the same principles used, specifically: (1) reduction, tunneling, tailoring, personalization, and self-monitoring; and (2) simulation, reduction, tunneling, self-monitoring, and personalization. The study (Coorey et al. 2019) resulted in 73% of its respondents agreeing on simulation being the most evident, while the study (Lucero et al. 2022) resulted in more than 80% of its respondents' preferring designs that featured tailoring. This suggests that Primary Task Support, and its aforementioned principles, have the most influence in a persuasive user experience, which is further reinforced by the study (Kim et al. 2019). That being said, it was also found that Dialogue Support (Kim et al. 2019; Lucero et al. 2022; Bartlett et al. 2017; Alpay et al. 2019; Coorey et al. 2019) and System Credibility Support (Kim et al. 2019; Lucero et al. 2022; Alpay et al. 2019; Coorey et al. 2019) were effective as well. Of all five (5) studies analyzed, Social Support was the least utilized and least evident compared to the other categories. This suggest that Social Support, while still important, is the least applicable to the situations of the papers.

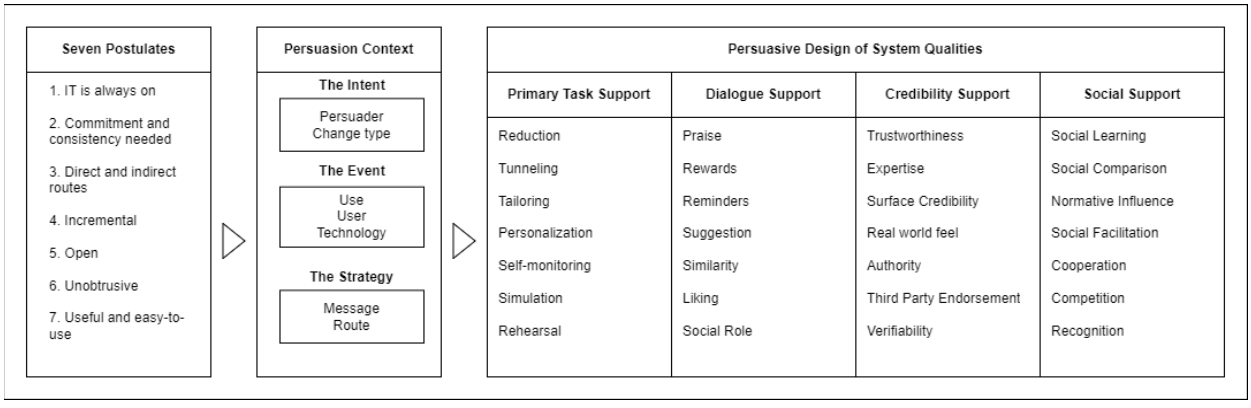

Figure 2. Phases of Persuasive System Design

Fogg Behavior Model (FBM). Proposed by B.J. Fogg, the FBM helps in understanding how a behavior occurs. According to the model, three factors must come together in order for an action to take place: motivation, ability, and trigger (Alpay et al. 2019). Should any of the three not be present, a behavior will not be enacted. Additionally, each factor has its own set of elements (Theopilus et al. 2018): motivation – pleasure or pain, hope or fear, and acceptance or rejection; ability – factors of simplicity (time, money, physical effort, brain cycles, social deviance, and non-routine); and trigger – spark, facilitator, and signal. The following figure, acquired from (Theopilus et al. 2018), illustrates the behavioral model. Only 2 (de Toledo et al. 2018; Alpay et al. 2019) of the 3 studies implementing FBM feature results that relate to the model. In that regard, both studies seek to integrate FBM into a personalized model or framework.

Therapeutic Persuasiveness. Therapeutic Persuasiveness describes the manner of which a product or system is made to help persuade its users to positively alter their behavior (Baumel et al. 2017). Thus, it typically includes five components, namely: call to action, load reduction of activities, use of adaptive content, constant feedback and rewards, and clear expectations and rationale (Baumel et al. 2017). One study found using therapeutic persuasiveness, it discovered a link between therapeutic persuasiveness and user engagement and content.

Cialdini's Principles of Social Influence. The principles of social influence used by the study (Ibrahim et al. 2018) were applied or manifested as persuasive visuals – added with other concepts of user experience such as usability, visual aesthetic, and engagement. Collectively, there are six principles (Ibrahim et al. 2018; Qasim et al. 2018): commitment and consistency (to an objective), authority, reciprocity (receiving of a reward), liking (influence from others), scarcity (demand of a lacking resource), and social proof (motivation under the observance of others). In doing so, two models were created: in the first model, the six principles are used as the dominant or primary variables; while the second model used the six principles as the primary constructs of social influence.

Lastly, the remaining two studies of the eleven selected papers are guidelines in developing or applying persuasive techniques. The first study (Kolesár 2018) features four different persuasive techniques: cognitive biases, social biases, gamification, and trust. These are in addition to offering different levels of processing design. The second study (Oduor et al. 2017), coauthored by Oinas-Kukkonen, features software design patterns for dialogue support in the persuasive system design. It particularly focused on the principles of praise, suggestion, reminders, and rewards. In doing so, it also provides three different patterns: reminder, reward, and instant feedback (combination of praise and suggestion).

3.3 Components in Remote Chronic Pain Management System

Pain could be defined as the unpleasant feeling and emotional experience connected to a potential or actual tissue damage. It could also be connected to other types of damages where there is no existence of any physical disorder (Finnerup 2019). Pain could be classified as chronic pain or persistent pain which is a type of recurring pain that has been happening for more than 3 months. It covers a wide range of conditions such as musculoskeletal pain, pain after surgery or trauma, persistent primary pain (e.g., back pain or neck pain), and so on (Devan et al. 2019). Chronic pain has been considered as one of the most widespread diseases worldwide and that it is a common reason that people seek medical care (Ghai et al. 2020; Varsi et al. 2021). This type of pain affects 1 in every 5 people, making it a leading cause of disability in the world (Devan et al. 2019). After establishing the definition and effects of chronic pain, it could now be seen as to why treatment or management of chronic pain is considered as an essential service (Ghai et al. 2020). Unfortunately, such services or interventions are not always accessible in-person and there are many barriers to accessing in-person pain services (Varsi et al. 2021; Devan et al. 2019). Such barriers could be long-waiting lists and transportation issues (Devan et al. 2019). This is where the need for a remote pain management system comes in. However, digital solutions for chronic pain are still limited and that a gap still exists between available digital self-help pain management programs and effective evidence-based interventions. Furthermore, there is also a lack of health care professional input during the development process of existing pain management systems (Varsi et al. 2021; Devan et al. 2019).

In order to properly develop a pain management system, past studies that have discussed such systems must be properly reviewed. Most of the existing studies about pain management systems are about mobile applications (Solem et al. 2020; Yang et al. 2018; Bhatia et al. 2021; Koumpouros 2021; Shah and Chiew 2019; Slepian et al. 2020) while there are some that focused on web applications (Oldenmenger et al. 2017; Richardson et al. 2021; Tipprom et al. 2018) because it allowed users to access the system on multiple devices or platforms (Oldenmenger et al. 2017; Tipprom et al. 2018). In most available pain management systems, it allowed for the users to assess their pain through some sort of form or questionnaire. Which is an important aspect since an effective chronic pain management relies

on proper pain assessments and clinical history (Ghai et al. 2020). Pain assessments are done to take note of progression (Tipprom et al. 2018) or symptoms (Devan et al. 2019; Bhatia et al. 2021). Table 3 below provides a summary of relevant findings from the chosen studies regarding pain assessments.

Table 3. Summary of Existing Pain Assessment Types or Forms

Types or Forms	Description	No. of Studies	References
Scale	Indicating Pain Intensity from 0 to 10 (no pain to worst pain).	5	Finnerup (2019); Bhatia et al. (2021); Slepian et al. (2020); Oldenmenger et al. (2017); Tipprom et al. (2018)
	Indicating Pain Intensity from 1 to 10.	1	Yang et al. (2018)
Location Indicator	Indicating the location of the painful area by clicking body parts through a body map.	5	Yang et al. (2018); Bhatia et al. (2021); Koumpouros (2021); Slepian et al. (2020); Kawai et al. (2017)
Questionnaire	Answering questions about the pain symptoms and any possible past events connected to the pain.	2	Bhatia et al. (2021); Slepian et al. (2020);
	Answering questions related to treatments/medications for the pain.	4	Yang et al. (2018); Bhatia et al. (2021); Slepian et al. (2020); Kawai et al. (2017)
	Answering questions which ask if relief was received from the medications.	1	Kawai et al. (2017)
	Answering questions about the character of the pain, timing of the pain, aggravating/alleviating factors of the pain, and what were the activities they have done for the day that mattered to them.	3	Yang et al. (2018); Bhatia et al. (2021); Slepian et al. (2020)
	Answering questions about how the pain has affected their daily activities/lives (such as sleeping, socializing, housework).	2	Koumpouros (2021); Kawai et al. (2017)
	Answering questions about anxiety, depression, and sleep issues caused by pain.	1	Ghai et al. (2020)
Pain History/ Record Keeping	The completed pain assessments could be stored and viewed on demand by the user.	5	Yang et al. (2018); Bhatia et al. (2021); Koumpouros (2021); Slepian et al. (2020); Tipprom et al. (2018)
	The completed pain assessments could be sent or accessed by health care professionals.	3	Bhatia et al. (2021); Slepian et al. (2020); Tipprom et al. (2018)

In regards to the actual management of pain, existing studies have also provided multiple pain strategies in order to alleviate the pain. Based on the chosen studies, some of them have mentioned self-management strategies for pain management (Finnerup 2019; Devan et al. 2019; Varsi et al. 2021). Self-management is a concept where individuals use strategies/ skills to daily manage their health and to play an important role in managing their condition (Finnerup 2019). Table 4 below provides a summary of relevant findings from the chosen studies regarding pain management strategies.

Table 4. Summary of Existing Non-Pharmacological Pain Management Strategies or Interventions

Strategies or Interventions	Description/Analysis	No. of Studies	References
Mindfulness-based or Psychological Interventions	It is an example of self-management interventions.	4	Finnerup (2019); Devan et al. (2019); Ghai et al. (2020); Shah and Chiew (2019)
	Have been found to be effective and showed promising consistent results for the treatment of persistent pain.	2	Devan et al. (2019); Majeeda et al. (2018)

	Includes stress-reduction, cognitive therapy, meditation, guided imagery, muscle relaxation, diaphragmatic breathing.	2	Devan et al. (2019); Shah and Chiew (2019)
	Most frequent form of mindfulness in self-management strategies were meditation and guided relaxation.	1	Devan et al. (2019);
	Music therapy has been used as a way to manage pain.	2	Yang et al. (2018); Honzel et al. (2019)
Physical Therapy or Activities	Physical exercises/therapy have also been mentioned as a form of strategy for pain management.	4	Finnerup (2019); Ghai et al. (2020); Tipprom et al. (2018); Akhtar et al. (2017)
	Physical therapy with core stabilization and routine exercises was effective in treating chronic back pain.	1	Akhtar et al. (2017)
	Physical exercises for knee pain could be prescribed by a therapist through a web application.	1	Tipprom et al. (2018)
Integrating Persuasive Technologies	Persuasive technology in pain management is important for motivation and engagement.	2	Varsi et al. (2021); Solem et al. (2020)
	It could be through supportive language or enjoyable design, promoting feelings of hope and continued use.	1	Varsi et al. (2021)
	It could be applied through a leveling system or by giving points or trophies to users.	2	Solem et al. (2020)

4. Proposed System

In order to make the most optimal user experience and interface, the aforementioned elements are to be applied to this proposed system by making it usable (Newton et al. 2021), have an appealing interface (Yu and Huang 2020; Agusdin et al. 2021), easily identifiable purpose (Copeland et al. 2018), and be practical for the user itself (Agusdin et al. 2021). These elements however are subjective; hence it will be evaluated by the most renowned method of user experience and usability evaluation which is the System Usability Scale (SUS) which has been shown to be previously used on eHealth applications as an effective way of assessing usability (Hurmuz et al. 2020; Islam et al. 2020; Anderson 2021; Marien et al. 2018; Rybarczyk et al. 2018). User Experience Questionnaire (UEQ) elements of user experience will also be applied, and is evaluated by the UEQ itself. These scales pertain to attractiveness, efficiency, perspicuity, dependability, stimulation, and novelty. UEQ will be used as to better define user experience scales to be applied to eHealth applications as from previously mentioned studies (Kushendriawan et al. 2021; Pérez-Rodriguez et al. 2021; Liu et al. 2020). In applying persuasive technology to the user experience design, the study will make use of the Persuasive System Design (PSD) framework developed by Oinas-Kukkonen and Harjumaa (2009). Based on the results of the studies (Kim et al. 2019; Lucero et al. 2022; Bartlett et al. 2017; Alpay et al. 2019; Coorey et al. 2019), the development model will consider the persuasion context - taking into consideration the personal situation of the user, as emphasized by the study of Orji and Moffatt (2018). In considering the findings of the studies (Lucero et al. 2022; Asbjørnsen et al. 2019), the proposed system features primary task support, dialogue support, and system credibility support as these are the most applicable to the context of the study. Additionally, the patterns identified by Oduor et al. (2017) and gamifications principles identified Kolesár (2018) were taken into consideration. Applying the principles under the PSD framework and the principles of design for UI/UX lends to both visual and content persuasiveness. In the creation of the proposed chronic pain management system, the decision of what modules to include in it would be based on the contents provided by existing pain management studies or systems. One of the things that were mentioned was the existence of pain assessment where a user could answer a questionnaire **(**Yang et al. 2018; Bhatia et al. 2021; Koumpouros 2021; Slepian et al. 2020**)**, or a scale (Finnerup 2019; Yang et al. 2018; Bhatia et al. 2021; Slepian et al. 2020; Oldenmenger et al. 2017; Tipprom et al. 2018), to provide details about their pain. Furthermore, non-pharmacological pain strategies were also mentioned to manage pain such as psychological interventions (Finnerup 2019; Devan et al. 2019; Ghai et al. 2020; Yang et al. 2018; Shah and Chiew 2019; Majeeda et al. 2018; Honzel et al. 2019; Cheever et al. 2018) and physical therapies (Finnerup 2019; Ghai et al. 2020; Tipprom et al. 2018; Akhtar et al. 2017). The integration of persuasive technology in pain management system was also mentioned in past studies for motivation and engagement (Varsi et al. 2021**;** Solem et al. 2020).

The proposed development model, as shown in Figure 3, considers the nature of the chronic pain plaguing an individual, which refers to their situation in dealing with the pain. Location, intensity, influence, and causes are all included in this context as this is important for consideration in developing the system. It also considers the current or

existing situation, practices or standards in regards to pain management such as the existence of pain assessment and psychological and physical pain strategies to alleviate pain. This is then used as input in implementing the Persuasive System Design (PSD) framework, which is in turn applied to the overall designing of the website. SUS assessment of the website is then evaluated for each development iteration of the website to ensure its usability, UEQ assessment is evaluated as well for the finished version of the website to ensure that all of the user experience and user interface elements and scales are up to an acceptable measure. Additionally, the evaluations serve to help indicate the effectiveness of the persuasive design. The website would then incorporate some of the modules that have been identified from past studies such as the pain assessment. The pain assessment would be available through a Brief Pain Inventory (BPI) scale that the users could answer in order to specify details about their pain such as the intensity, location, medications taken and level of interference to daily activities. On the other hand, the pain strategies that would be available in the system would be both physical and psychological exercises. It would be accompanied with persuasive technologies such as leveling system, badges and points to promote engagement and motivation.

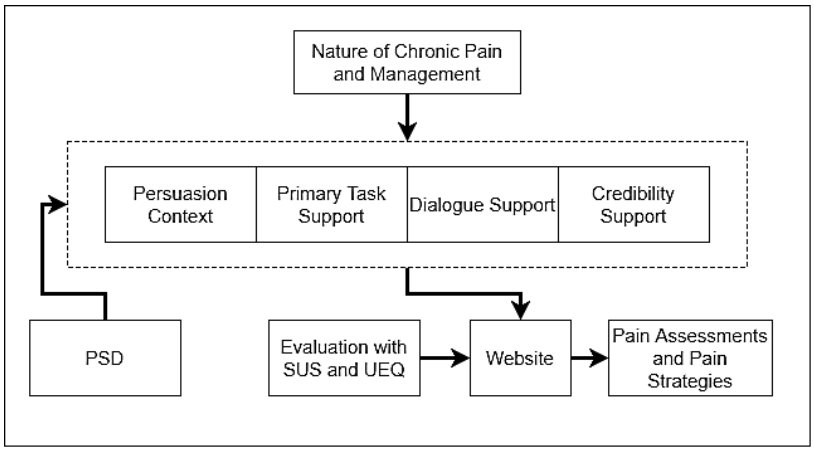

Figure 3. Proposed Development Model for Chronic Pain Management Web App using Persuasive Technology

5. Implication and Conclusion

The research paper presented generally succeeds in achieving its goals, having identified elements in user experience and user interface design, a framework for applying persuasive technology, and the components to be implemented in remote chronic pain management. Having done so, it subsequently applies the (selected) aforementioned in proposing a development model for a web application applying persuasive technology for chronic pain management. In collecting over 157 related studies, it was filtered down into 51 studies based on a filtering process shown in Figure 1. The most prevalent evaluation tools for user experience design are the System Usability Scale (SUS) and User Experience Questionnaire (UEQ). The elements in the UEQ are taken into consideration for the proposed system's design. Among the possible models, frameworks, or principles available for persuasive technology application, it was found that the Persuasive System Design (PSD) framework was the most used, which was also used for this study. The selected pain assessment tool is the Brief Pain Inventory (BPI), and the pain management process will include both physical and psychological-based interventions. As such, the results of the research process can be used as reference for future studies looking to apply persuasive technology to web applications for chronic pain management. Moreover, the proposed system can be used as reference in future web application development efforts in eHealth.

6. Limitation and Future Research

This section is directed towards future research if the topic of the study is of similarity. There can be more literature to include in the filtration process. The chosen criteria for selecting papers are also limited to not being tested or validated but do have referenced basis. This paper is only meant to approach, define and apply various concepts that are needed to be applied towards the persuasive technology-centered eHealth application, the actual application of these methods for development has yet to commence.

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